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Geology of Mount Monadnock

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Trip C-1: Geology of Mount Monadnock

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ITINERARY

Text precedes Trip B-2. Trip consists of a hike to the summit of Mt. Monadnock, weather permitting. In case of rain we will visit lower elevations. Assembly point is Keene State College Commons Parking Lot, 8:30 a.m. Participants should bring water and lunches. Topographic maps: Monadnock 15' quadrangle OR Monadnock Mountain 7.5' X 15' quadrangle.

Mileage

0.0 Take Wyman Way to Main Street.

0.2 Right (S) on Main Street.

0.5 Left (E) on Rte. 101.

1.8 Hills to N and S are Clough Quartzite on east edge of Keene dome.

3.9 Fitzwilliam Granite south side of road.

4.4 Marlboro village -- poor exposures of Rangeley Formation.

4.6 Right (S) on Rte. 124. Stay on Rte. 124 to Mt. Monadnock.

5.7 Abandoned granite quarry to left (Fitzwilliam Granite).

6.5-6.9 Rangeley outcrops in woods, both sides of road.

7.8 Spaulding Tonalite north of road. Plutonic rocks here to foot of Mt. Monadnock, intruding the west limb of the Monadnock syncline.

10.4 Perkins Pond. View of Mt. Monadnock. Pass Troy Road, right.

11.2 Spaulding Tonalite on right.

11.3-11.4 Littleton Fm. on left, intruded by granite.

11.9 Turn left into parking area for White Arrow trail to Mt. Monadnock. We will visit Silurian units on the east limb of Monadnock syncline (Fig. 1), and then spend the rest of the day in Devonian Littleton Fm.

STOP 1: Proceed on foot up old toll road (Half Way House Road) 650 feet to outcrop, right side of road: Francestown Fm., bedding oriented N14E, 44 NW. Proceed 115 feet up road to small bedrock exposure in left road bank (Francestown) and go west into woods perpendicular to strike to more Francestown outcrops on small ridge.

Proceed N70W to stonewall, north 60 feet along wall, cross at flag, and go another 100 feet north up slope to conspicuous outcrop west of wall: lower part of the Warner Fm. Thinly bedded calc-silicate granulite. Pink quartz-garnet-clinozoisite-diopside layers, green actinolite-quartz-anorthite-microcline layers, gray to white quartz-epidote-diopside layers. Bedding N38E, 40 NW.

Continue NW perpendicular to strike about 100 feet to an outcrop of Fitzwilliam Granite at E-W stonewall and Warner Fm. 20 feet beyond. Continue NW perpendicular to strike 75 feet to outcrop of upper part of Warner Fm. and 18-inch granite sill. Follow strike NE 50 feet to

Trip C-1, Fig.1. Geology of Mt. Monadnock area. Gray pattern indicates outcrops. Stops 7 & 8 are between Stop 6 and summit (triangle). Formations abbreviated as on text Fig.3. Mmd—microdiorite dike; Mfg—Fitzwilliam Granite; Dst—Spaulding Tonalite; Dlu7q—Seven quartzites in the upper Littleton Fm.

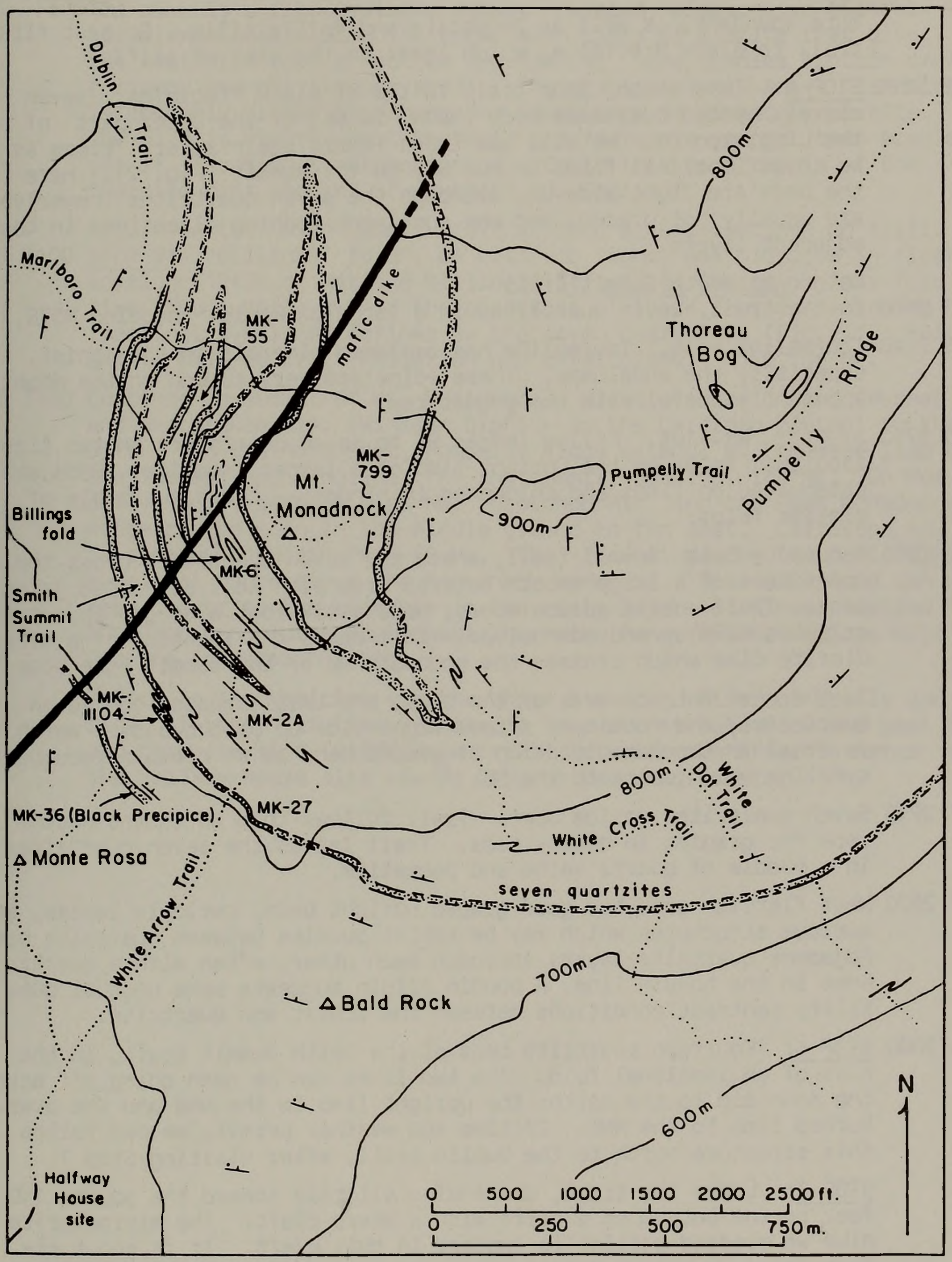
more Warner, then perpendicular NW 60 feet to outcrop near ridgeline: upper Warner quartz-plagioclase-biotite granulite, with calc-silicate pod.

Follow contour of land east, passing round granite boulder, and at 220 feet another Warner outcrop (poison ivy abounds), and 200 more feet back to toll road. Continue up road.

Watch for Littleton Fm. outcrops at left edge of road. Just beyond here road levels out (elevation 516 m, 1695 ft).

Elevation

m	ft	
546	1790	At next steep pitch, ledge of atypical, somewhat rusty Littleton. Parker trail and spur to right lead 750 feet to excellent exposure of lower Littleton and view southeast (optional stop).
		Beyond dip in road, Littleton outcrops and stonewall on right.
		600 feet farther on right, Littleton outcrops.
576	1890	400 feet farther on right, glacially striated outcrop of Littleton. Striae and grooves oriented N55W.
620	2035	STOP 2. Freshly exposed outcrops in trail where trail leaves road: quartz-biotite-muscovite-garnet-sillimanite schist, typical of lower part of Littleton Fm. in Zone III. Quartzite layers are thin and widely spaced or absent. At clearing (old Halfway House site), schist is intruded by pegmatite. View of west side of Mt. Monadnock: bedding dips away from us; flat surfaces are joints.
		Proceed through clearing on main trail. Where White Arrow trail starts up steeply over rocks, take Fairy Spring trail to left, across brook and past 1855 Fassett's Mountain House site.
686	2250	Trail levels out. Ledge to right with upright graded quartzite bed.
707	2320	Fairy Spring. Widely spaced, thin quartzite layers.
719	2360	Trail goes up over ledge with yellow blaze: upright graded bed and coticule layer.
735	2410	Bear right (up) on Monte Rosa trail.
739	2425	Bear left to Monte Rosa (white blazes).
774	2540	STOP 3: Monte Rosa. 180° view from Mt. Wachusett (S25E) to Mt. Ascutney (N25W). Low country to west is underlain by Fitzwilliam Granite and Spaulding Tonalite. Summit of Gap Mtn.(S30W) is made of Littleton and Silurian xenoliths (roof pendants?) surrounded by Spaulding. Troy (S65W) lies in the southern extension of the Monadnock syncline, which parallels the ridge of Little Monadnock to the left of Troy. Berkshire-Green Mountains on the western skyline: Greylock at S80W and Stratton Mountain at N70W.
		On the highest part of Monte Rosa there are good examples of unaltered sillimanite pseudomorphs after andalusite, resistant to weathering.
		In the next outcrop area toward Monadnock, beyond woods (near the "Tooth"): large isoclinal folds, tens of feet in amplitude, close both NW and SE. Foliation parallels the axial planes: N39W, 41 NE.
		Continue on Smith Summit trail toward the top. Quartzite beds become



Trip C-1, Fig.2. Geology of Mt. Monadnock summit, showing isoclinal folds marked by the "seven quartzites". Trip C-1 follows the Smith Summit Trail from Monte Rosa to the summit.

m	ft	
		more abundant, as well as pegmatite and aplite sills. Go past first trail to Black Precipice, which leads to the base of cliff.
798	2620	STOP 4: Take second spur trail to top of Black Precipice: seven closely bedded quartzite beds (N63W, 26 NE) of the upper part of the Littleton Fm. We will see these layers again several times as we cross isoclinal folds on our way to the summit (Fig. 2). Here the beds are right-side-up, although the seven quartzites themselves are usually not graded, and one must seek topping directions in the adjacent layers.
		Return to Smith Summit trail.
811	2660	In the trail, seven quartzites in a large backfold: bedding N57E, 52 SE.
835	2740	Tourmaline vein. Tourmaline has replaced minerals in the schist, especially the andalumps. These veins are very common on the mountain, apparently coeval with the pegmatites.
850	2790	STOP 5: MK-1104. Follow ledges SE to seven quartzites in two tight isoclinal folds on the upright limb of a larger isocline. Beds are attenuated on limbs and thickened in hinges -- classic example of similar folds.
855	2805	Return to Smith Summit trail, where the seven quartzites cross the upper part of a large smooth outcrop area with well developed joint sets. Trail enters spruce woods; note a six-foot-wide gap in outcrop oriented N45E up and down slope. This marks the location of a microdiorite dike which crosses the mountain NW of the summit (see Stop 7).
		In the next outcrop west of the dike, the trail crosses the seven quartzites, and continues across right-side-up graded beds. Watch for reversal in topping direction of graded beds as we cross a recumbent syncline which opens to the SE.
887	2910	Seven quartzites upside down. Trail follows them up to the north. Look for grading in nearby beds. Trail leaves the seven quartzites in a muddle of quartz veins and pegmatite.
893	2930	Next flattish area has good graded upright beds, coticule lenses, and curious structures which may be schist boudins between quartzite beds. Adjacent quartzite layers approach each other, often with a quartz knot in the boudin line. A boudin origin suggests some unusual ductility contrast conditions between the schist and quartzite.
914	3000	STOP 6: Fourteen quartzite beds at the Smith Summit trail, in the nose of an isoclinal fold. The two limbs can be seen going off across the mountain to the north: the upright limb to the NNW and the overturned limb to the NNE. If time and weather permit, we may follow this structure north to the Dublin trail, after visiting Stop 7.
		STOP 7: Leave the trail, descending slightly toward the south, 150 feet to the bottom of a cliff with a sharp cleft. The microdiorite dike we crossed earlier is exposed in this cleft. It is about six feet thick, nearly vertical, and cuts across all folds in the Littleton. It is cut by tourmaline and pegmatite veins. It is parallel to granite dikes where it is last seen SW of Monte Rosa, and contact relations suggest it is about the same age as the Fitzwilliam Granite.

m	ft	
		The dike is a fine-grained, weakly foliated, plagioclase-biotite-hornblende-quartz-ilmenite rock, with clots of biotite that give the weathered rock a spotted appearance. Some samples contain small corroded garnets (xenocrysts?). The plagioclase is An_{45}. Ilmenite is commonly rimmed by sphene and hornblende is rimmed by biotite. The dike is clearly post-tectonic and therefore younger than Acadian, yet it is somewhat metamorphosed. Could this be a result of the "Permian disturbance" of southern New England?
		Return to the Smith Summit trail at Stop 6, and continue up trail.
945	3100	STOP 8: "Billings' fold", on cliff to right, was pictured in first edition (1942) of Marland Billings' Structural Geology. This fold lies structurally within the uppermost of three southeast-opening isoclinal synclines defined by the seven quartzites (Fig. 2). Fold axis: N58E at 32°. Foliation and axial plane: N16W, 36 NE.
963	3160	Continue to summit of Mt. Monadnock. Views of Dublin Pond (Warner Fm.) and Skatutakee Mtn. (Kinsman Granite in the Cardigan pluton) to the north. To the northeast, Pumpelly Ridge extends as the east limb of the Thoreau Bog syncline. At the summit, bedding dips NE. On Pumpelly Ridge, bedding dips NW. Crotched Mtn. and the Pack Monadnock Range can be seen in the middle ground to the east. Littleton Fm. is exposed on North Pack (Duke, 1984) in what may be the next higher synclinal nappe above the Monadnock syncline. Thorndike Pond can be seen closer to the mountain in the east; layers of Kinsman extend from the Cardigan pluton south past Thorndike Pond toward the Coys Hill Granite in Massachusetts.
		Return to the vehicles via the White Arrow and Sidefoot trails and the old toll road. If time permits, a loop across Bald Rock and past the old graphite mine (Cliff Walk trail) is worth the effort. Return to the Halfway House site via Do Drop or Hedgehog trails.